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TECHNICAL REPORT NO. 67-10

OPERATION OF UBSO

Quarterly Report No. 3

1 November 1966 through 31 January 1967

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GEOTECH

A TELEDYNE COMPANY

TECHNICAL REPORT NO. 67-10

OPERATION OF UBSO, QUARTERLY REPORT NO. 3
1 November 1966 through 31 January 1967

GEOTECH
A TELEDYNE COMPANY
3401 Shiloh Road
Garland, Texas

20 February 1967

IDENTIFICATION

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Project Title:	Operation of UBSO
ARPA Order No:	624
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Name of Contractor:	Teledyne Industries, Geotech Division Garland, Texas
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Program Manager:	B. B. Leichliter, BR 1-2561 Garland, Texas

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ABSTRACT

This report describes the operation of the Uinta Basin Seismological Observatory (UBSO) from 1 November 1966 through 31 January 1967. Modifications and additions to the observatory instrumentation are described, and tests to improve the operations of the observatory are reported. Also discussed is the status of special investigations designed to evaluate and improve the detection capability of the observatory.

OPERATION OF UBSO - QUARTERLY REPORT NO. 3
1 November 1966 through 31 January 1967

1. INTRODUCTION

1.1 AUTHORITY

The work described in this report was supported by the Advanced Research Projects Agency, Nuclear Test Detection Office, and was monitored by the Air Force Technical Applications Center (AFTAC), under Contract AF 33(657)-16563. The statement of work for this contract is shown in appendix 1.

1.2 HISTORY

Uinta Basin Seismological Observatory (UBSO) was constructed under Contract AF 33(657)-7185. Site selection and noise surveys were accomplished by Geotech, A Teledyne Company (formerly The Geotechnical Corporation); the final decision on the observatory location was made by AFTAC. Texas Instruments Incorporated (TI) was responsible for the construction of all physical facilities.

Contract AF 33(600)-43486, issued to TI, contained the authority for equipping and operating UBSO. The instrumentation was supplied by Geotech and was installed under the direction of Geotech personnel under subcontract to TI. TI operated the observatory from November 1962 until 1 July 1963. Under Projects VT/1124 and VT/5054, Contract AF 33(657)-12373, Geotech operated UBSO from 1 July 1963 through 30 April 1966.

2. OPERATION OF UBSO

2.1 GENERAL

Data are recorded at UBSO on a 24-hour basis. The observatory is normally manned 8 to 10 hours a day, 5 days a week. On week-ends and holidays, a skeleton crew mans the observatory 8 hours a day; however, additional personnel are on call in case of emergency.

2.2 SEISMOGRAPH OPERATING PARAMETERS

2.2.1 Standard Seismographs

The operating parameters and the tolerances for the standard observatory seismographs are shown in table 1. These parameters are reset, as necessary, when the frequency response of a seismograph is found to be out of tolerance. The frequency response norms and their respective tolerances are shown in

Table 1. Operating parameters and tolerances of seismographs at UBSO

Seismograph				Operating parameters and tolerances					Filter settings	
		Seismometer								
System	Comp	Type	Model	T_s	λ_s	T_g	λ_g	σ^2	Bandpass at 3 dB cutoff (sec)	Cut off rate at SP side (dB/oct)
SP	Z and H	Johnson-Matheson	7515, 6480	1.25 ±2%	0.51 ±5%	0.33 ±5%	0.65 ±5%	0.03	0.1-100	12
SP	SZ	Geotech	18300	1.25 ±2%	0.51 ±5%	0.33 ±5%	0.65 ±5%	0.053	0.1-100	12
SP	Z	UA Benioff	1051	1.0 ±5%	1.0	0.083 ±5%	≈1.4	1.0	-	-
IB	Z	Melton	10012	2.5 ±5%	0.65 ±5%	0.64 ±5%	1.2 ±5%	0.018	0.05-100	12
IB	H	Geotech	8700B	2.5 ±5%	0.65 ±5%	0.64 ±5%	1.2 ±5%	0.001	0.05-100	12
BB	Z	Geotech	7505	12.5 ±5%	0.485 ±5%	0.64 ±5%	9.0 ±5%	0.0007	0.05-100	12
BB	H	Geotech	8700A	12.5 ±5%	0.485	0.64 ±5%	9.0 ±5%	0.0007	0.05-100	12
LP	Z	Geotech	7505A	20.0 ±5%	0.74 ±5%	110 ±10%	0.85 ±10%	0.63	25-1000	12
LP	H	Geotech	8700A	20.0 ±5%	0.74 ±5%	110 ±10%	0.85 ±10%	0.63	25-1000	12

KEY

SP	Short period	T_s	Seismometer free period (sec)
IB	Intermediate band (currently inactive)	T_g	Galvanometer free period (sec)
BB	Broad band	λ_s	Seismometer damping constant
LP	Long period	λ_g	Galvanometer damping constant
UA	Unamplified (i.e., earth powered)	σ^2	Coupling coefficient

table 2. The frequency responses of the UBSO seismographs, as normally operated, are shown in figure 1.

2.2.2 Filters for Multichannel Array Processors (MAP)

All MAP channels utilize a band-pass filter with the following settings: a high-cut corner frequency of 3 cps at 3 dB per octave cutoff rate, and a low-cut corner frequency of 1 cps at 12 dB per octave cutoff rate.

2.2.3 Filters for Surface and Shallow-Buried Array Summations

Summations of the 10-element surface array and the 10-element shallow-buried array are each filtered by a band-pass filter with the following settings: a high-cut corner frequency of 3 cps and a low-cut corner frequency of 0.8 cps, both at a cutoff rate of 18 dB per octave.

2.2.4 Filters for Vertical Array Summations

The six elements of the vertical array are summed and two outputs are recorded. From the beginning of the reporting period until 13 December, one of the outputs (ΣDH) was filtered by a band-pass filter with the following settings: a high-cut corner frequency of 5 cps and a low-cut corner frequency of 0.375 cps, both at a cutoff rate of 24 dB per octave. On 13 December, the cutoff rates for both the high-cut and low-cut sections of the filter were changed to 0 dB per octave. Therefore, from 13 December to the end of the reporting period, ΣDH was an unfiltered summation. Throughout the reporting period, the second output (ΣDHF) was filtered by a band-pass filter with the following settings: a high-cut corner frequency of 3 cps at a cutoff rate of 24 dB per octave and a low-cut corner frequency of 0.75 cps at a cutoff rate of 36 dB per octave.

2.3 DATA CHANNEL ASSIGNMENTS

Several recording format changes were made during the reporting period. On 8 December, we established 16-millimeter film Data Group 5062 on which is recorded a three-component short-period system at a magnification of 5 K at 1 cps. On 9 December, recording of the outputs of the elements of the surface array on magnetic tape was discontinued, and Data Groups 5029 and 5031 were initiated. Data Group 5029 includes a three-component short-period system recorded on magnetic tape at low gain. Magnetic-tape Data Group 5031 includes the USO ZSP, ZLP, and Time, MCF's 1, 3, and 4 from MAP I, and MCF's 11, 12, and 13 from MAP II. On 17 December, the time encoder output from tape recorder No. 1 was added to 16-millimeter film, and WWV was added to the MAP I and MAP II Develocorders when Data Groups 5068, 5070, and 5072 were established. The current data-channel assignments and normal operating magnifications for all UBSO data groups are presented in table 3. The key to the designators used in the data-channel assignments is given in table 4.

Table 2. **Calibration norms and operating tolerances for frequency responses of the standard seismographs at UBSO**

SP Vertical 18300 and
SP Johnson-Matheson
Vertical and Horizontal

f (cps)	T (sec)	R. M.	A. T. (±%)
0.2	5.0	0.0113	10
0.4	2.5	0.0950	7.5
0.8	1.25	0.685	5
1.0	1.0	1.0	-
1.5	0.67	1.52	5
2.0	0.5	1.90	5
3.0	0.33	2.12	7.5
4.0	0.25	1.87	12
6.0	0.167	1.15	20
8.0	0.125		
10.0	0.100		

LP Vertical and Horizontal [c]

f (cps)	T (sec)	R. M.	A. T. (±%)
0.01	100	0.246	20
0.0125	80	0.377	20
0.0167	60	0.589	15
0.02	50	0.745	15
0.025	40	0.899	10
0.033	30	1.06	5
0.04	25	1.0	-
0.05	20	0.822	5
0.0667	15	0.506	10
0.10	10	0.173	20
0.143	7	b	a

IB Vertical and Horizontal

f (cps)	T (sec)	R. M.	A. T. (±%)
0.1	10.0	0.0090	25
0.2	5.0	0.068	20
0.3	3.3	0.25	15
0.4	2.5	0.46	10
0.5	2.0	0.64	5
0.7	1.43	0.86	5
1.0	1.0	1.0	-
1.5	0.67	1.04	5
2.0	0.5	1.0	10
3.0	0.33	0.89	15
5.0	0.2	0.66	20

BB Vertical and Horizontal

f (cps)	T (sec)	R. M.	A. T. (±%)
0.04	25.0	0.104	20
0.06	16.7	0.350	20
0.08	12.5	0.775	15
0.1	10.0	0.950	10
0.2	5.0	1.0	5
0.4	2.5	1.0	5
0.8	1.25	1.0	-
1.6	0.625	1.0	5
3.2	0.312	1.0	10
6.4	0.156	0.980	15

KEY

R. M. Relative magnification
A. T. Amplitude tolerance
a Tolerance not established in the period
b Measurements not reliable due to interference from microseismic background noise
c These norms and tolerances, apply to the broad-response long-period system (LP1).

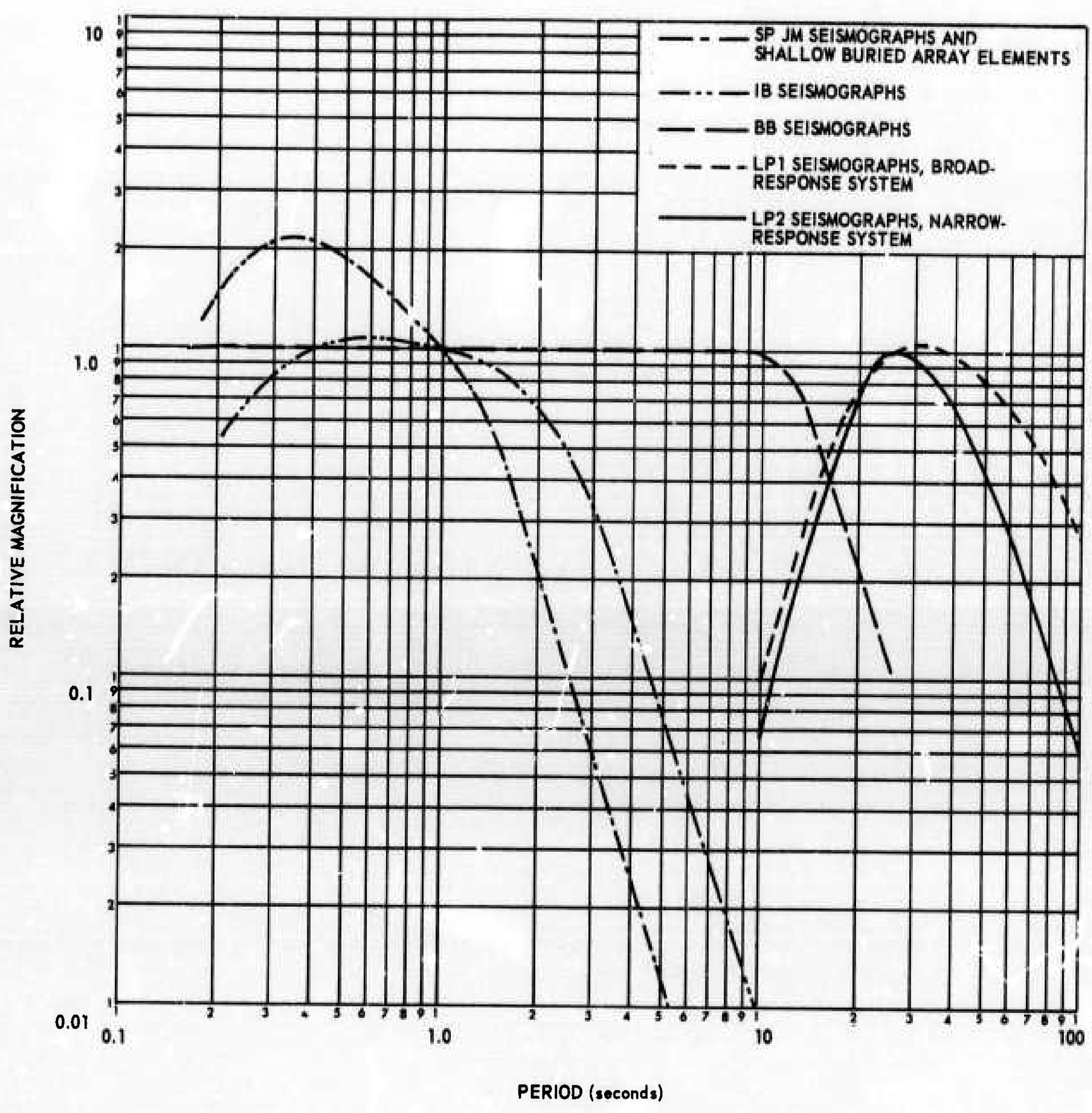


Figure 1. Normalized response characteristics of the standard seismographs at UBSO

G 1438

Table 3. Data Channel Assignments and Normal Operating Magnifications at UBSO

DEVELOCORDERS

FAST SPEED 30mm/min.

DATA GROUP 5044 SP Primary

Channel	Trace	Mag.
1	V	20K
2	SZ1	600K
3	SZ3	600K
4	SZ5	600K
5	SZ2	600K
6	SZ4	600K
7	SZ6	600K
8	SZ7	600K
9	SZ8	600K
10	SZ9	600K
11	ΣSSF	6000K
12	ΣSS	1500K
13	SZ10	600K
14	NSP	600K
15	ESP	600K
16	WWV	---

DATA GROUP 5064

Channel	Trace	Mag.
1	V	2K
2	MS1	0.75μb/mm
3	MS2	0.75μb/mm
4	DH6	1000K
5	DH5	1000K
6	DH4	1000K
7	DH3	1000K
8	DH2	1000K
9	DH1	1000K
10	ΣDHF	6000K
11	ΣDH	1500K
12	SZ8	600K
13	USO-SP	---
14	USO-Time	---
15	WI $\frac{3\ \text{mph/mm}}{S=0/8\ \text{mm}\ (E=6)}$	
16	WWV	---

DATA GROUP 5068

Channel	Trace	Mag.
1	SZ10L	60K
2	NSPL	60K
3	ESPL	60K
4	Z10LL	5K
5	NSPLL	5K
6	ESPLL	5K
7	Z1	600K
8	Z3	600K
9	Z5	600K
10	ΣSF	6000K
11	ΣS	1500K
12	Z2	600K
13	Z6	600K
14	Z10	600K
15	TCMDG (Tape #1)	---
16	WWV	---

DATA GROUP 5070 MAP I

Channel	Trace	Mag.
1	Test	---
2	MCF4	Testing
3	MCF1	Testing
4	MCF3	Testing
5	BSS1	Testing
6	BSS2	Testing
7	BSS3	Testing
8	BSS4	Testing
9	BSS5	Testing
10	BSS6	Testing
11	ΣSBS	Testing
12	WWV	-----

DATA GROUP 5072 MAP II

Channel	Trace	Mag.
1	Test	---
2	MCF11	Testing
3	MCF12	Testing
4	MCF13	Testing
5	MCF14	Testing
6	MCF15	Testing
7	MCF16	Testing
8	MCF17	Testing
9	BSSV1	Testing
10	BSSV2	Testing
11	BSSV3	Testing
12	BSSV4	Testing
13	BSSV5	Testing
14	BSSV6	Testing
15	ΣDVS	Testing
16	WWV	-----

SLOW SPEED 3mm/min.

DATA GROUP 5066

Channel	Trace	Mag.
1	WI $\frac{3\ \text{mph/mm}}{S=0/8\ \text{mm}\ (E=6)}$	
2	SZ2	300K
3	ZLP1	25K
4	NLP1	25K
5	ELP1	25K
6	NLPS	20K
7	ZLP2	100K
8	NLP2	100K
9	ELP2	100K
10	ML1	3.0μb/mm
11	ML2	3.0μb/mm
12	USO-LP	---
13	ZEB	1.0K
14	NBB	1.0K
15	EBB	1.0K
16	WWV	----

MAGNETIC TAPE RECORDERS

DATA GROUP 5029 No. 1 Channel	Trace	DATA GROUP 5023 No. 2 Channel	Trace	DATA GROUP 5025 No. 3 Channel	Trace	DATA GROUP 5031 No. 4 Channel	Trace
1	TCMDG	1	TCMDG	1	TCMDG	1	Sta. Time
2	DH 1	2	ZBB	2	SZ 1	2	USOZSP
3	DH 2	3	NBB	3	SZ 2	3	USOZLP
4	DH 3	4	EBB	4	SZ 3	4	USO Time
5	DH 4	5	NSP	5	SZ 4	5	ΣS
6	DH 5	6	ESP	6	SZ 5	6	ΣSSF
7	Comp.	7	Comp.	7	Comp.	7	Comp.
8	DH 6	8	ZLP 1	8	SZ 6	8	MCF 1
9	ΣDH	9	NLP 1	9	SZ 7	9	MCF 3
10	ΣDHF	10	ELP 1	10	SZ 8	10	MCF 4
11	Z10LL	11	ZLP 2	11	SZ 9	11	MCF 11
12	NSPLL	12	NLP 2	12	SZ 10	12	MCF 12
13	ESPLL	13	ELP 2	13	ΣSS	13	MCF 13
14	WWV & Voice	14	WWV & Voice	14	WWV & Voice	14	WWV & Voice

Table 4. Key to the designations used in the data format assignments at UBSO

Z	Amplified vertical short-period seismograph from a site identified by a suffix number	ZBB	Vertical broad-band seismograph
		NBB	North-south broad-band seismograph
NSP	Amplified north-south short-period seismograph	EBB	East-west broad-band seismograph
ESP	Amplified east-west short-period seismograph	ΣS	Summation of Z1 through Z10
		ΣSF	ΣS filtered
V	Unamplified vertical short-period seismograph	ΣSS	Summation of SZ1 through SZ10
ZLP1	Vertical long-period seismograph, broad response	ΣSSF	ΣSS filtered
		DH1	Vertical array element at 8895 feet
NLP1	North-south long-period seismograph, broad response	DH2	Vertical array element at 7903 feet
ELP1	East-west long-period seismograph, broad response	DH3	Vertical array element at 6910 feet
ZLP2	Vertical long-period seismograph, narrow response	DH4	Vertical array element at 5894 feet
NLP2	North-south long-period seismograph, narrow response	DH5	Vertical array element at 4901 feet
ELP2	East-west long-period seismograph, narrow response	DH6	Vertical array element at 3907 feet
NLPS	North-south long-period seismograph, broad response (operated in surface tank)	ΣDH	Summation of DH1 through DH6
		ΣDHF	ΣDH filtered
MS1	Short-period microbarograph (inside LP vault)	ML1	Long-period microbarograph (inside LP vault)
MS2	Short-period microbarograph (outside LP vault)	ML2	Long-period microbarograph (outside LP vault)
WI	Anemometer-wind speed and direction	MCF3	Multichannel filter: 8.1 ∞km/sec velocity signal and measured noise correlations (not including road noise) using Z1 - Z10
WWV	Radio time (WWV, STS, and voice on tape)		

Table 4. Continued

Test	Test instrumentation
Comp	Compensation
Mag	Magnification (see note)
TCMDG	Time code management data Group
USO-SP	Unmanned seismological observatory short-period seismograph
USO-LP	Unmanned seismological observatory long-period seismograph
MCF1	Multichannel filter: ∞velocity signal and measured noise correlations (not including road noise) using Z1 - Z10
MCF4	Multichannel filter: ∞velocity signal and measured noise correlations including road noise), using Z1 - Z10
MCF12	Multichannel filter: ∞velocity signal and theoretical noise model using SZ1 - SZ10 and DH1 - DH6
MCF13	Multichannel filter: ∞velocity signal and theoretical noise model using DH1 - DH6
MCF14	Deghost filter: up-going ∞velocity P wave signal and theoretical noise model using DH1, DH3, and DH5
MCF15	Deghost filter: down-going ∞velocity P wave signal and theoretical noise model, using DH1, DH3, and DH5
BSS1	Beam-steered summation: 8.1 km/sec signal from azimuth of 0°, using Z1 - Z10
BSS2	Beam-steered summation: 8.1 km/sec signal from azimuth of 60°, using Z1 - Z10
BSS3	Beam-steered summation: 8.1 km/sec signal from azimuth of 120°, using Z1 - Z10
BSS4	Beam-steered summation: 8.1 km/sec signal from azimuth of 180°, using Z1 - Z10
BSS5	Beam-steered summation: 8.1 km/sec signal from azimuth of 240°, using Z1 - Z10
BSS6	Beam-steered summation: 8.1 km/sec signal from azimuth of 300°, using Z1 - Z10
ΣSBS	Summation of Z1 - Z10, with MAP band-pass filter
MCF11	Multichannel filter: ∞velocity signal and measured noise correlations (not including road noise), using SZ1 - SZ10
BSSV2	Beam-steered summation: up-going 8.1 km/sec P wave, using DH1 - DH6
BSSV3	Beam-steered summation: up-going 8.1 km/sec S wave, using DH1 - DH6
BSSV4	Beam-steered summation: down-going ∞velocity P wave, using DH1 - DH6
BSSV5	Beam-steered summation: down-going 8.1 km/sec P wave, using DH1 - DH6

Table 4. Continued

MCF16	Deghost filter: up-going ∞velocity P wave signal and theoretical noise model, using DH2, DH4, and DH6
MCF17	Deghost filter: down-going ∞velocity P wave signal and theoretical noise model, using DH2, DH4, and DH6
BSSV1	Beam-steered summation: up-going ∞velocity P wave, using DH1 - DH6
BSSV6	Beam-steered summation: down-going 8.1 km/sec S wave, using DH1 - DH6
ΣDVS	Summation of SZ1 - SZ10 and DH1 - DH6, with MAP band-pass filter

NOTE

Magnification of:

Short-period measured at 1 cps
Broad-band measured at 0.8 cps
Long-period measured at 0.04 cps
MCF measured at 1 cps
BSS measured at 1 cps

2.4 SHIPMENT OF DATA TO THE SEISMIC DATA LABORATORY (SDL)

Magnetic-tape seismograms are shipped to SDL with the regular Long Range Seismic Measurements (LRSM) Program data shipment about 15 days after the end of the month during which they were recorded. The magnetic-tape No. 1 seismograms recorded at UBSO through 31 December 1966 and magnetic-tape No. 2 seismograms recorded through August 1966 have been shipped to SDL.

All 16-millimeter film seismograms recorded at UBSO through 30 November were sent to SDL. More recent films are currently held in Garland for special studies.

2.5 QUALITY CONTROL

Quality control checks were made on randomly selected runs of all recordings from the observatory. Results of the checks were sent to the observatory for corrective action as necessary.

2.6 "G" MEASUREMENTS ON THREE-COMPONENT SHORT-PERIOD AND BROAD-BAND SYSTEMS

On 2 November, "G" checks were performed on the three-component short-period and broad-band systems, and adjustments were made to those elements found to be out of tolerance. The results of these tests are listed in table 5. On 1 November the equivalent weight for SZ10 was determined to be 42.8 milligrams.

Table 5. "G" checks on short-period and broad band three-component systems-2 November 1966

	G before adjustment	G after adjustment
Z10	0.452	0.431
NSP	0.437	0.437
ESP	0.423	0.423
ZBB	80.2	80.2
NBB	80.3	80.3
EBB	78.4	78.4

2.7 SECURITY INSPECTION

Mr. William J. Robertson, Industrial Security Specialist, visited the observatory on 18 January for a facility security inspection. All observatory security procedures were found to be in order.

2.8 SHIPMENT OF TEST EQUIPMENT TO TFSO

To facilitate determination of phase and amplitude responses of portable system instrumentation at TFSO, the Hewlett-Packard (H-P) variable phase function generator assigned to UBSO was shipped to TFSO on 20 January.

3. EVALUATE DATA AND PROVIDE MOST EFFECTIVE OBSERVATORY POSSIBLE

3.1 MODIFICATIONS TO INSTRUMENTATION AT UBSO

3. .1 Modifications to Frequency Response of Elements of the Vertical Array

In order to make the frequency response of the elements of the vertical array more nearly match the standard J-M frequency response, a modification was made on 14 November to the band-pass filter of each element of the vertical array, resulting in a high-cut rate of 6 dB per octave from a corner frequency of 5 cps. The average of the frequency responses of the six elements of the vertical array, as currently operated, and the standard J-M frequency response are presented in figure 2.

3.1.2 Modified 1 kW Power Amplifier, Model 22183

The modified 1 kW Power Amplifier, Model 22183, was received and installed on 3 November. On several occasions during this reporting period, the power amplifier failed during adjustments to the timing system. Each time the timing system is adjusted (when the timing error exceeds ±25 milliseconds), the 1 kW power amplifier protective circuit opens, resulting in loss of power to UBSO instrumentation. In most cases, the 1 kW power amplifier was restarted without difficulty. On 7 January, it was necessary to replace two power transistors in the power amplifier. On 16 January, when the system switched to line power, the line power fuse opened, causing a complete shut-down of all recording systems except the magnetic-tape recorders. Five hours of film data were lost due to this power failure. Magnetic-tape seismograms for the period of lost film data were sent to our Garland laboratory for film play-out. The film play-backs were received 27 January. The data were analyzed and sent to Garland before the end of the reporting period.

The 1 kW power amplifier failed again on 21 January. The trouble was traced to several defective transistors in the protective circuits. New transistors were installed on 23 January.

3.1.3 Timing System, Model 11880

The Timing System, Model 11880, required frequent adjustment during the reporting period. The timing system was in error by more than 50 milliseconds 7 times in November, 3 times in December, and 2 times in January.

On 16 January, during a shut-down of the 1 kW power amplifier, a modified strobe unit was installed in the primary timing system.

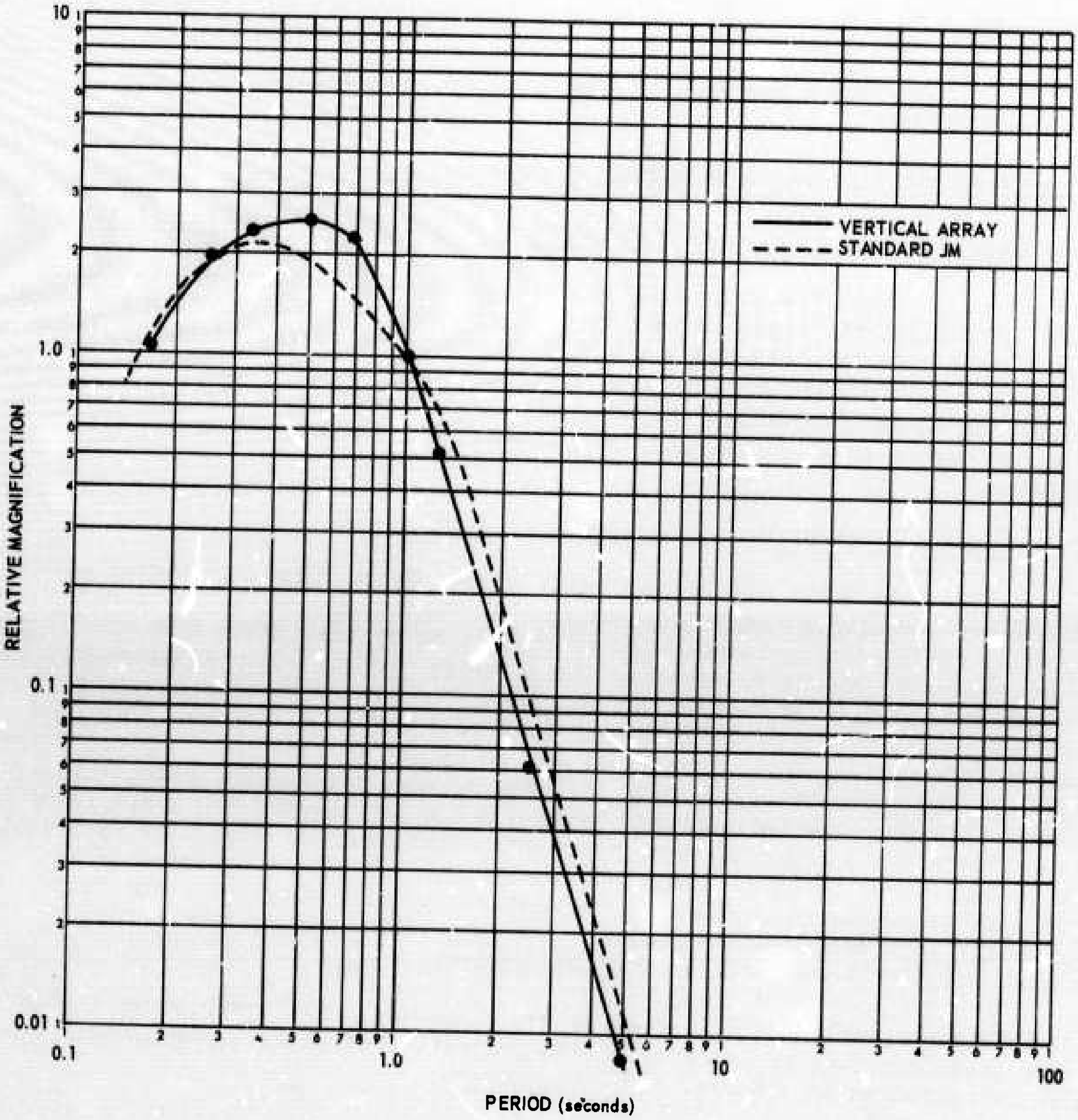


Figure 2. Mean normalized frequency response of elements of vertical array (30 December 1966) compared to standard JM response

G 2210

3.1.4 Magnetic-Tape Recorder No. 4

Because a calibration control unit was not supplied with magnetic tape recorder No. 4, a temporary unit was constructed by UBSO personnel to allow calibration of the recording oscillators. A Calibration Control Unit, Model 9300, shipped from our Garland laboratory, was installed in magnetic-tape recorder No. 4 on 24 January.

Because of fluctuations in the internal frequency-regulated power supply of tape recorder No. 4, the internal supply was disconnected and the 1 kW Power Amplifier, Model 22183, was connected in its place. This change has resulted in more stable operation for tape recorder No. 4.

Because of excessive head wear on tape recorder No. 4, a set of spare heads was obtained from WMSO. There is no provision for aligning these heads on the recorder; consequently, they were aligned by trial and error. The signal-noise ratio (S/N) on tape recorder No. 4 is currently about equal to the S/N on the other three tape recorders at UBSO.

3.1.5 Change in Gain of Earth-Powered Seismographs

At the request of the Project Officer, the gains of the earth-powered vertical Benioff seismographs were changed on 23 November from 17K and 1.7K to 4.97K and 1.33 K, respectively. On 20 December, the gains were changed to 20K and 2K, respectively.

3.1.6 Frequency Responses of Low-Gain Seismographs

Because of the anticipated need for gains below the range of the PTA attenuators, during special recording intervals, special T-pad attenuators were constructed by UBSO personnel for the following systems:

SZ10	Z2
Z10	Z4
NSP	Z6
ESP	ZLP
SZ1	NLP
SZ3	ELP
SZ5	

Frequency responses with the T-pads installed are presented in figure 3 for Z6, ELP1, and ELP2.

3.2 ADDITIONS TO INSTRUMENTATION AT UBSO

3.2.1 Low-Gain Short-Period Seismographs

At the request of the Project Officer, a three-component short-period system operated at 5K magnification was installed on 8 December and is being recorded on magnetic tape and 16-millimeter film. Although we had planned to use SZ10 for the vertical component of this system, snow conditions prevented laying the necessary line of spiral-four cable to the PTA housing. Data are currently being taken from the Z10 line termination module and routed to a separate PTA through a decoupling, resistive network.

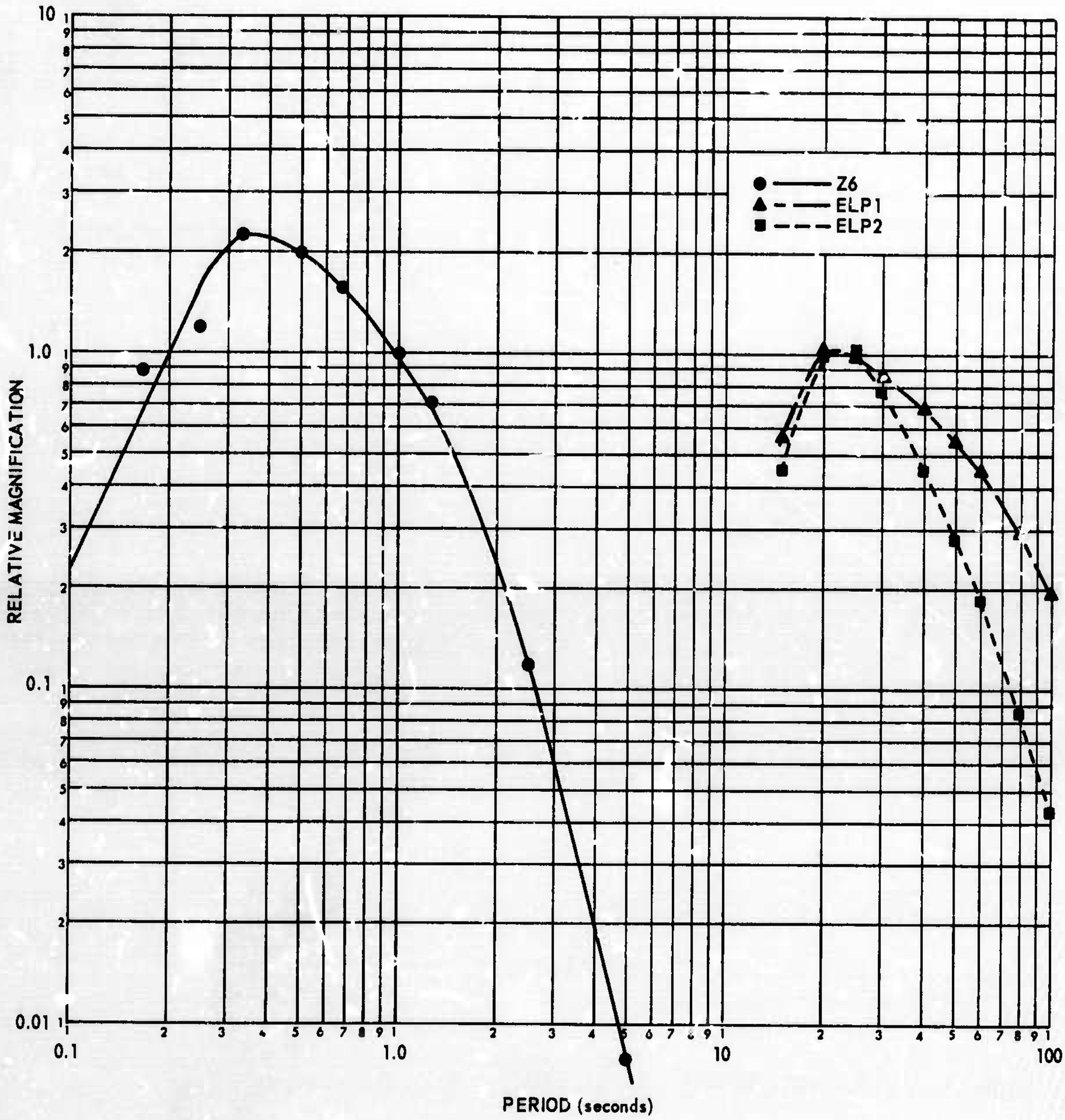


Figure 3. Normalized frequency responses of Z6, ELP1, and ELP2 with special T-pad attenuators

G 2211

3.2.2 Long-Period Cable Ditch

In late November, work was begun on the multiconductor cable burial ditch from the central recording building to the long-period vault. Persistent snow cover has prevented completion of the ditch.

4. TRANSMIT DAILY MESSAGES TO THE USC&GS

The arrival time, period, and amplitude measurements for events recorded at UBSO were reported daily to the director of the USC&GS in Washington, D. C. The number of events, by type, reported by UBSO during each month in this reporting period, is shown in table 6. The total number of events recorded by the observatory, the number of epicenters determined by the USC&GS and reported in the "Earthquake Data Report," and the percentage of the hypocenters in which UBSO data were utilized, are given in table 7, for August through October 1966. Lists of more recent epicenters have not been completed by the USC&GS.

Table 6. Number of earthquakes reported to the USC&GS by UBSO during November and December 1966 and January 1967

	Local	Near regional	Regional	Teleseismic	Total
November	27	397	28	1179	1631
December	41	364	41	1138	1584
January	22	433	40	1495	1990

Table 7. Percentage of hypocenters reported in the USC&GS "Earthquake Data Report" for which UBSO data were used

	Events reported by UBSO	Hypocenters reported by USC&GS	Percent of USC&GS events utilizing UBSO data
August 1966	2208	469	69.1
September 1966	1935	419	63.8
October 1966	1961	387	75.5

5. PUBLISH MONTHLY EARTHQUAKE BULLETIN

Data from UBSO were combined with data from BMSO, CPSO, TFSO, and WMSO and published in a multistation earthquake bulletin. The bulletins for June, July, and August 1966 were published and distributed during the reporting period. The September 1966 bulletin is being printed, and distribution is scheduled for

mid-February 1967. Data for October, November, and December 1966 were keypunched, transcribed onto magnetic tape, and sent to SDL for processing. Keypunching of the January 1967 data was about 35 percent complete at the end of the reporting period.

6. MAINTAIN UBSO FACILITIES

6.1 AIR CONDITIONING SYSTEM

On 15 November, the actuator circuits of the air conditioner hot water control valve became inoperative. The trouble was traced to a relay on the control panel. New relays have been ordered.

On 18 November, a coil mounting bracket in one compressor motor starter relay was found broken, causing a short circuit which destroyed four motor starter capacitors. Temporary repairs were made to allow air conditioner operation. The cause of this failure is attributed to weakening of the coil bracket by excessive heat from the fire and by vibration of the compressors.

The two time-delay relays, which were used to switch 220 volts to the condenser fan upon demand from a 110-volt control signal, were replaced with a conventional solenoid-type relay. The Amperite time-delay relay that switches 220 volts ac power to the compressors after the condenser fan has started, was left in the circuit. However, we plan to install a more conventional heavy-duty relay after our present supply of these relay tubes is exhausted.

6.2 FIRE-DAMAGED BOILER ROOM

On 8 November, the motor controller on the hot water supply was repaired. Insulation on several of the power wires to the motor controller had melted, causing an intermittent short circuit. A complete set of new wire was pulled through the conduit.

By 10 January, repairs to the boiler room, including repainting and clean-up, were completed.

6.3 MODIFICATION TO TEST PIER

A shelf was mounted on the side of the test pier to hold the six vertical-array PTA power amplifiers. The new shelf will enable us to retain some working room on the test pier.

6.4 SCRAP CABLE FROM VERTICAL ARRAY

As a result of the fishing operations on the vertical array last summer, there was approximately 8000 feet of scrap cable on the ground at the deep-hole site. On 30 November and 1 December, the cable was picked up by Moon Lake Electric Association. All the cable was coiled and tied in 800- to 1000-foot sections.

6.5 GRAVEL FOR PARKING LOT

Eight cubic yards of gravel was obtained for the parking lot on 29 November. A snow storm prevented the back-hoe, which was on the site for another project, from carrying and spreading the gravel.

6.6 ROAD MAINTENANCE

On 26 January, Uintah County personnel plowed the access road to the observatory.

7. MAINTAIN UBSO EQUIPMENT

7.1 FLOODING OF DEVELOCORDERS

During the reporting period, there have been numerous Develocorder outages due to flooding which was caused by slime build-up in the drain systems. The Utah Department of Health is conducting chemical analyses on water and slime samples from the Develocorders. We expect a report on these analyses during the last part of February. On 30 January UBSO personnel began adding "Dowicide-G" algacide to the Develocorder water supply twice a day, in an attempt to control the slime build-up.

Many of the Develocorder galvonometer blocks have been damaged by the flooding. On 22 December, a new galvonometer block was received and placed in operation in Develocorder No. 1. The galvonometer block that was removed was sent to our Garland laboratory for repair. Eventually, all galvonometer blocks will be returned to Garland for repair.

7.2 REPAIR OF SECONDARY CLOCK

The pivot pin of the lower relay on the secondary (snychronome) clock broke on 23 December. A replacement was improvised by UBSO personnel from a drill bit and operation was restored on 27 December. The improvised pivot pin broke on 11 January and the relay was sent to our Garland laboratory for repair. The repaired relay was received and installed on 23 January.

7.3 REPLACEMENT OF TUBES IN MICROBAROGRAPH NO. 1

On 9 December, new tubes were installed in the transducer of microbarograph system No. 1.

7.4 SHORTS IN STATION PROTECTOR BOXES

To prevent shorts in the station protector boxes caused by frost, a 100-watt light bulb was installed in each of the three station protector boxes at UBSO.

7.5 DEVELOCORDER RECORDING BULBS

Both recording bulbs in Develocorder No. 4 were burned out on 4 January, resulting in a loss of 2 hours and 17 minutes of surface array data.

7.6 S & E VOLTAGE REGULATOR

One power transistor in the Stevens-Evans (S-E) voltage regulator failed on 4 January, and three power transistors failed on 23 January. The regulator which is rated at a maximum load of 10.0 amperes, is now carrying a load of 8.8 amperes. We are currently investigating other regulators which will provide increased capacity.

8. INSTRUMENT EVALUATION

8.1 EVALUATION OF VERTICAL ARRAY

8.1.1 Malfunction of DH3 and DH2

Throughout the reporting period, the seismometer mass in DH3 (located 6910 feet below the surface) had been drifting to the lower stop. In an attempt to eliminate this difficulty, the mass was repeatedly locked and unlocked, and the mass was driven hard against the stop with a current of 80 mA through the transducer coil. Neither effort eliminated the drifting. Normal mass centering procedures have been successful in returning DH3 to operation. On 10 January, during routine "G" checks on the vertical array, the weight-lift unit in DH2 was found to be inoperative. Subsequent tests indicated that the trouble was in the seismometer. In addition, DH2 has developed a tendency to drift to the stops.

8.1.2 "G" Measurements on Elements of Vertical Array

"G" checks were performed on the elements of the vertical array on 31 October, 18 November, 21 December, and 10 January. Results of these tests are listed in table 8.

Table 8. "G" measurements on elements of vertical array

	31 October G	18 November G	21 December G	10 January G
DH1	0.658	0.636	0.640	0.673
DH2	0.659	0.635	0.615	--
DH3	0.243	0.258	0.264	0.276
DH4	0.709	0.705	0.716	0.715
DH5	0.553	0.538	0.617	0.604
DH6	0.589	0.621	0.617	0.620

8.1.3 Polarity Reversal on ΣDH

On 13 December, when the filter settings on ΣDH were changed so that the filter would perform an isolating function only, it was discovered that the polarity of ΣDH had been reversed. The reversal probably occurred during the changeover of the elements of the vertical array from tape recorder No. 4 to tape recorder No. 1 on 8 December.

8.2 EVALUATION OF UNDERGROUND LONG-PERIOD VAULT

On 2 December, UBSO analysts began collecting samples of wind-generated noise recorded on the long-period seismographs. To date, there have been too few occurrances of high wind to make a useful comparison of the relative sensitivities to this type of noise of the long-period seismometers in the deep long-period vault and the surface vault.

Examples of very long-period noise caused by pressure changes, not associated with high wind, are presented in figures 4 and 5. The narrow response long-period seismographs (ZLP2, NLP2, and ELP2) show very little response to these large pressure variations, even though operating at a gain of approximately 100K. The broad response horizontal long-period seismographs (NLP1 and ELP1) show much greater response to pressure change than do the narrow response horizontal seismographs. However, NLP1 usually shows 5 to 10 dB less response to pressure change than does the control horizontal seismometer (NLPS) located at the surface adjacent to the 50-foot vault. In every case, the vertical long-period seismographs are much less sensitive to pressure changes than are the horizontal long-period seismographs.

8.3 TECHNICAL ASSISTANCE AND MONITOR OF SANDIA'S USO

During the reporting period, the power supply of the Sandia USO has failed several times because of the flame on the thermo-electric generator blowing out. Sandia believes the flame-outs are due to moisture in the gas freezing as the mixture is passed through the regulator. At the request of Sandia, two quarts of absolute anhydrous methanol was injected into the fuel tank for the USO generator.

On 27 December, Sandia requested a check of the USO system. All instruments were operating. The time encoder was in error because of the many power system failures earlier in the month. No further troubles have been encountered with the power system.

A three-component operational amplifier was installed in the USO circuits on 27 December to record USO ZSP, ZLP, and time encoder on magnetic tape. Polarities of the USO systems were checked and found to be correct on 30 December. This system is now operational.

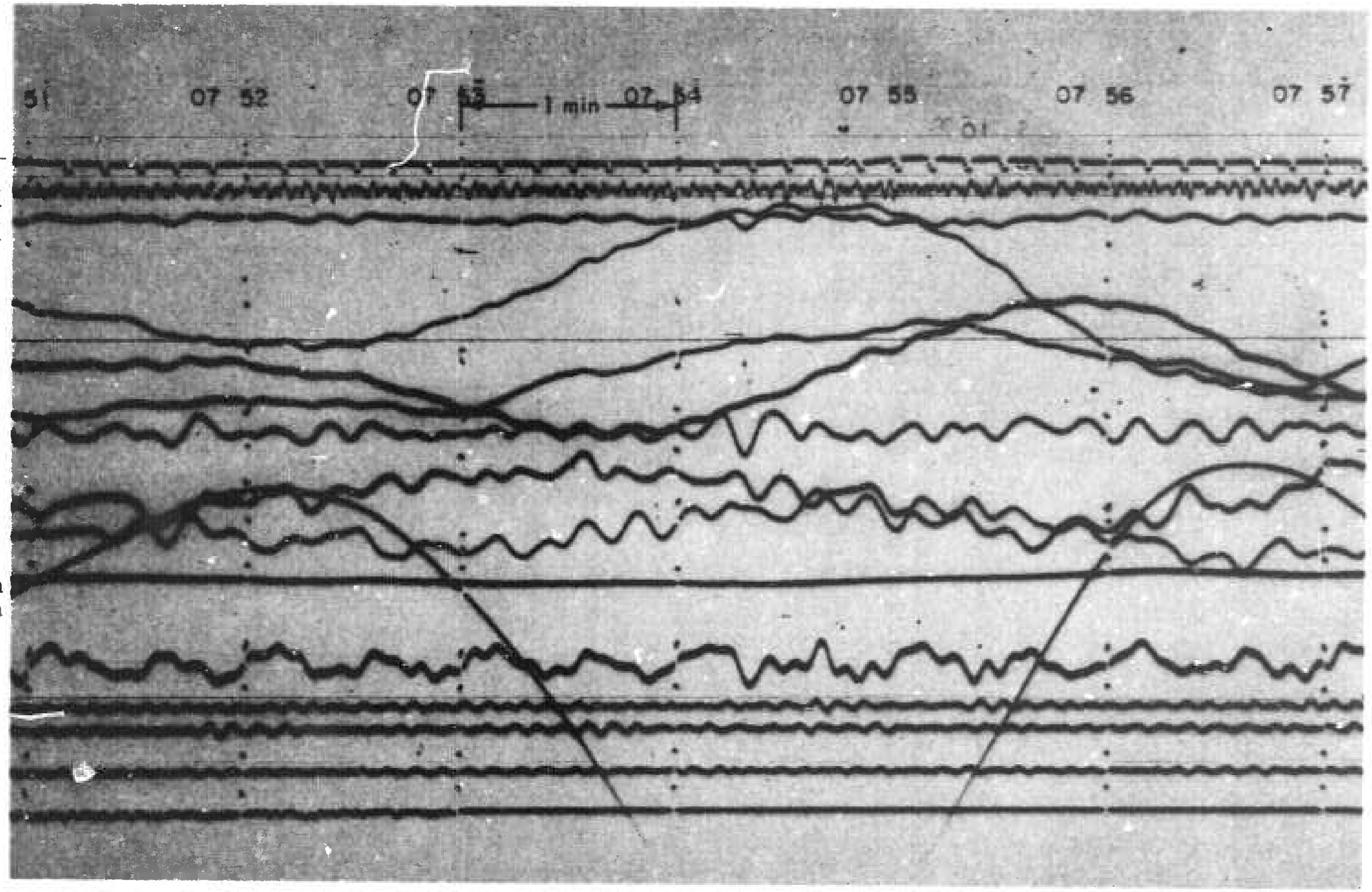


Figure 4. Long-period seismograph showing the response of the underground vault and the surface vault to pressure changes not associated with high wind (X10 enlargement of 16-millimeter film)

UBSO
12 Jan 67
RUN 012
DG 5066

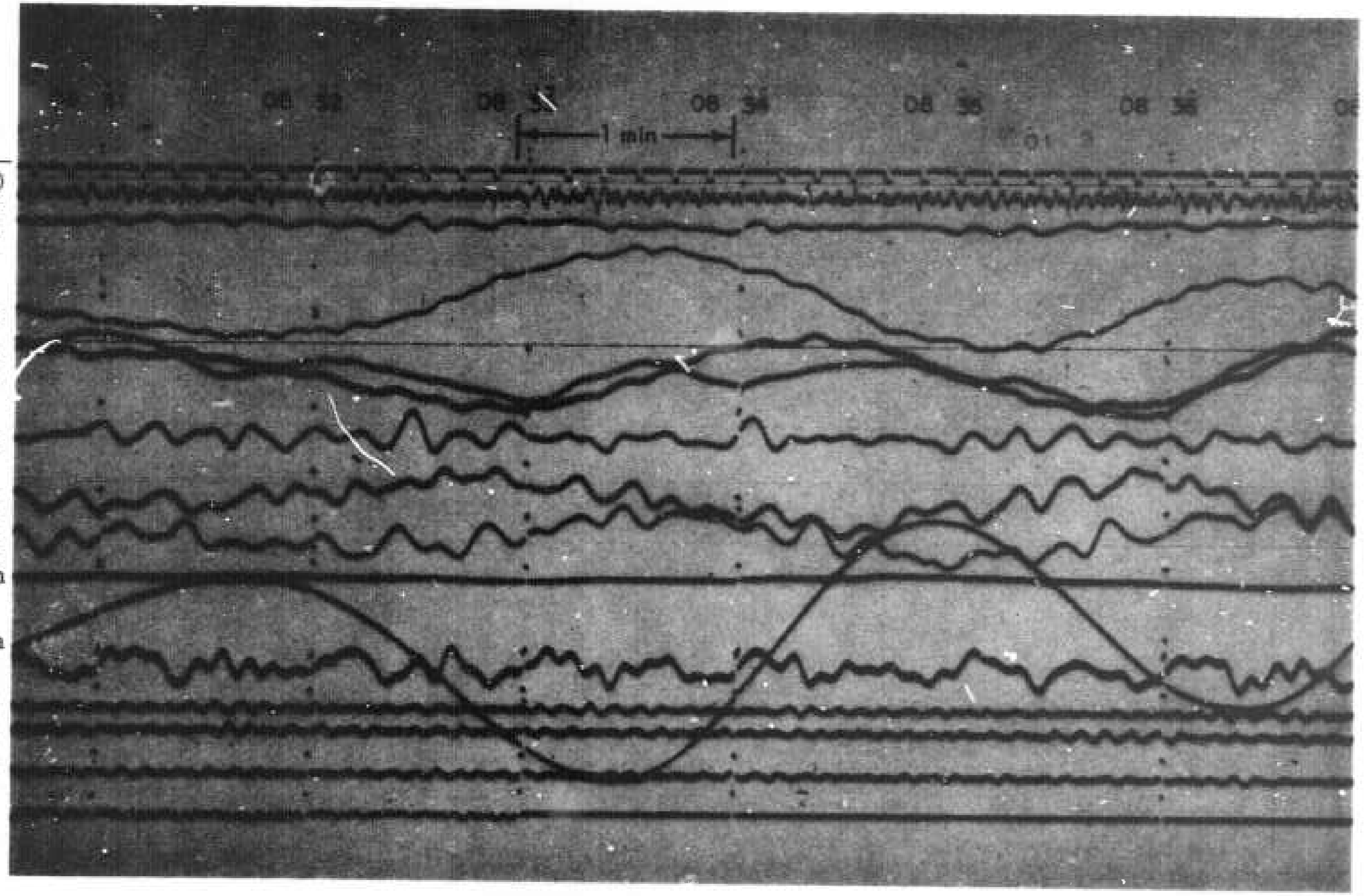


Figure 5. Long-period seismogram showing the effect of pressure changes on the instruments in the underground vault and the surface vault (X10 enlargement of 16-millimeter film)

On 31 January, three Sandia representatives installed a new tape recorder and made a general check of the USO system.

9. SPECIAL INVESTIGATIONS

9.1 EVALUATION OF MAP

9.1.1 MAP Maintenance

On 25 January, one of the operational amplifiers in MCF12 was replaced because of excessive dc offset. On 30 January, routine spot checks of MCF13 indicated that the equalizer amplifier gains were out of adjustment. A relative amplitude response run at 1.0 cps indicated that several outputs were low. Gains of the equalizer amplifiers of MCF13 were adjusted to bring the response back to standard.

9.1.2 Comparison of MCF4 with MCF1

Examples of high-frequency background noise arriving from north or northwest (interpreted to be highway noise) recorded on MCF4 and MCF1 are presented in figures 6 through 8. For the noise samples shown in figures 6 and 7, MCF4 gave greater attenuation of the high-frequency noise than did MCF1. For the more persistent noise shown in figure 8, MCF4 and MCF1 gave about the same attenuation of the high-frequency noise and both were slightly more effective than straight summation (SBS). Examples of high-frequency noise arriving from east and southeast are presented in figures 9 and 10. In both of these examples, neither MCF4 nor MCF1 was more effective in attenuating the high-frequency noise than was SBS.

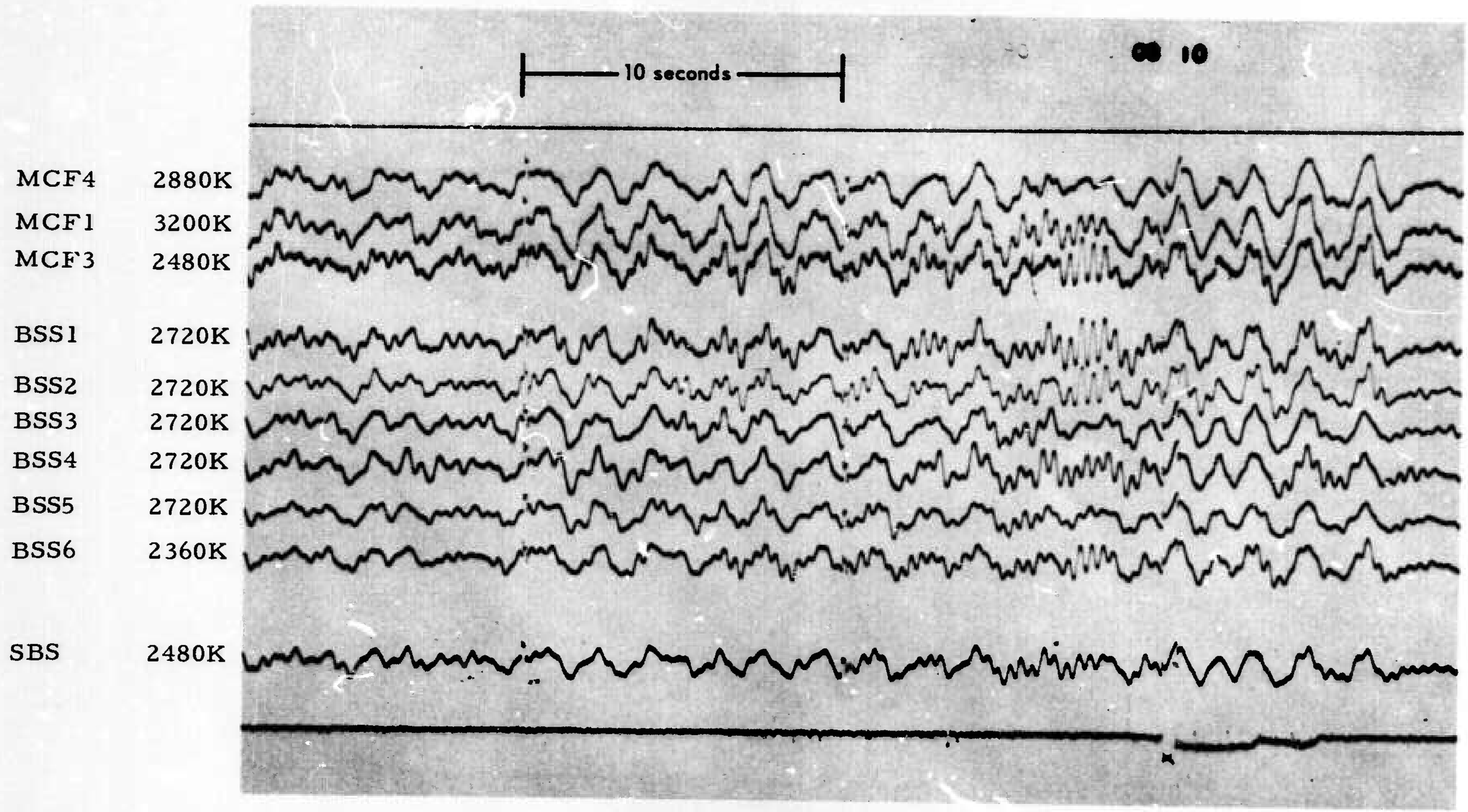
9.1.3 Special MCF4 and SBS Frequency Responses

At the request of the Project Officer and TI, special amplitude and phase frequency responses for MCF 4 and SBS were run, beginning on 12 December. Results of these tests were mailed to the Project Officer and to TI on 29 December.

9.1.4 Calibration of MAP II

During the daily calibration of MAP II, it has been necessary to use two function generators when both the vertical array and the shallow-buried array were calibrated simultaneously. Phase shift between the two function generators caused the calibrations to be invalid.

On 7 December, UBSO personnel constructed a voltage divider so that both arrays may be calibrated simultaneously, using only one function generator. This system has been used for MAP II calibrations since 7 December.



UBSO
01 Jan 67
RUN 001
DG 5070

Figure 6. MAP I seismogram showing response of MAP I system to high-frequency cultural noise arriving from a northerly direction (X10 enlargement of 16-millimeter film)

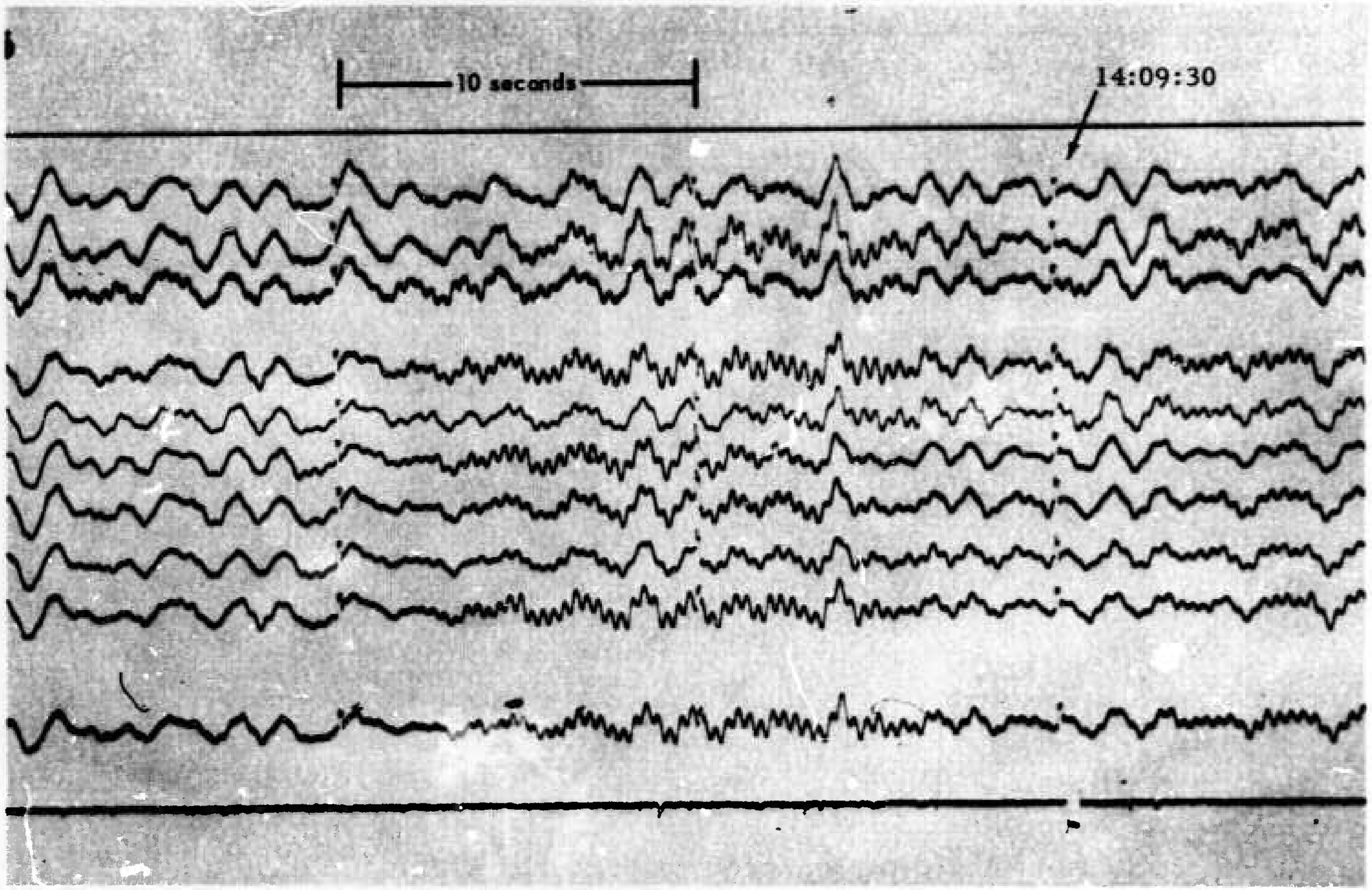
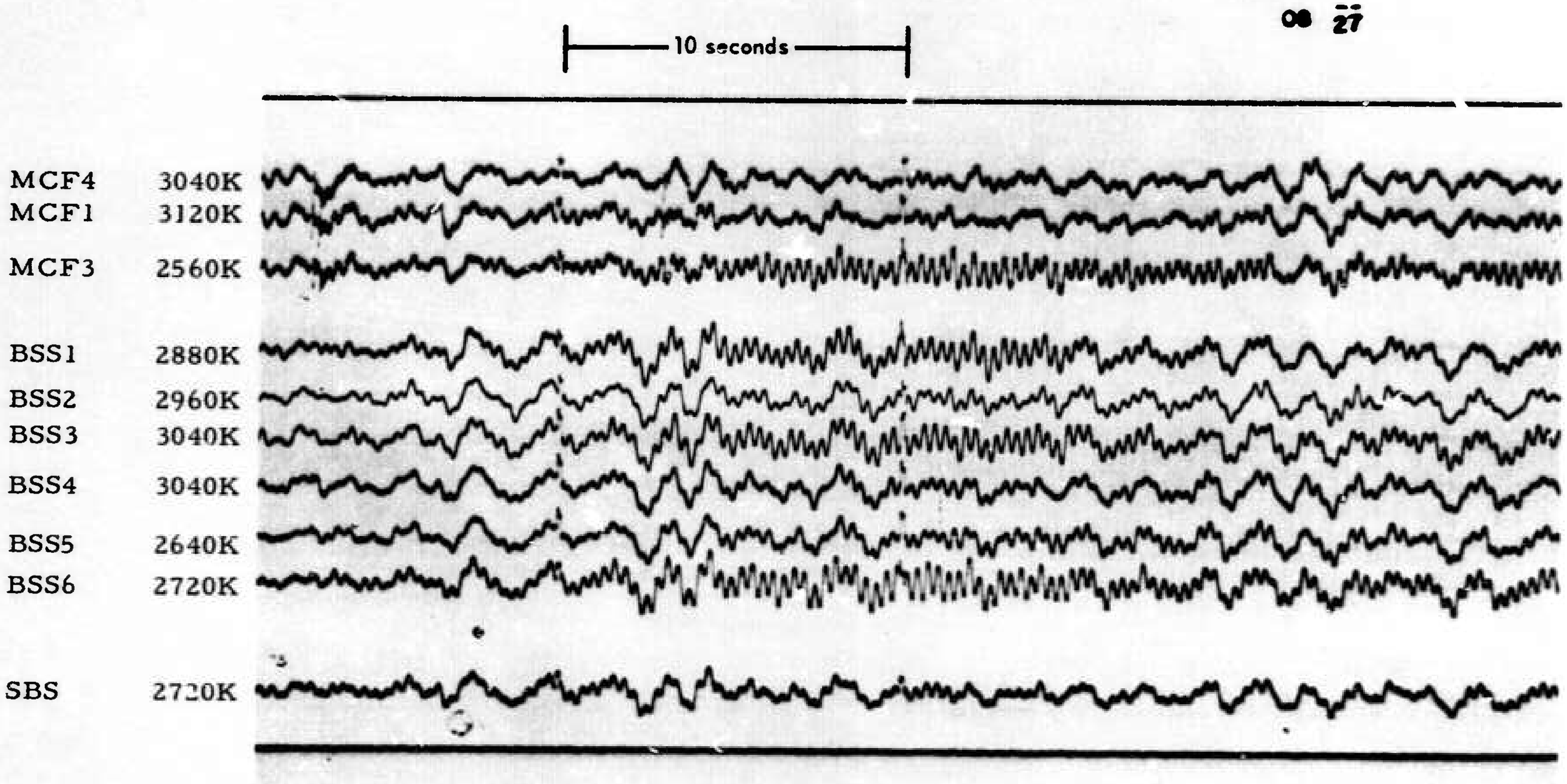
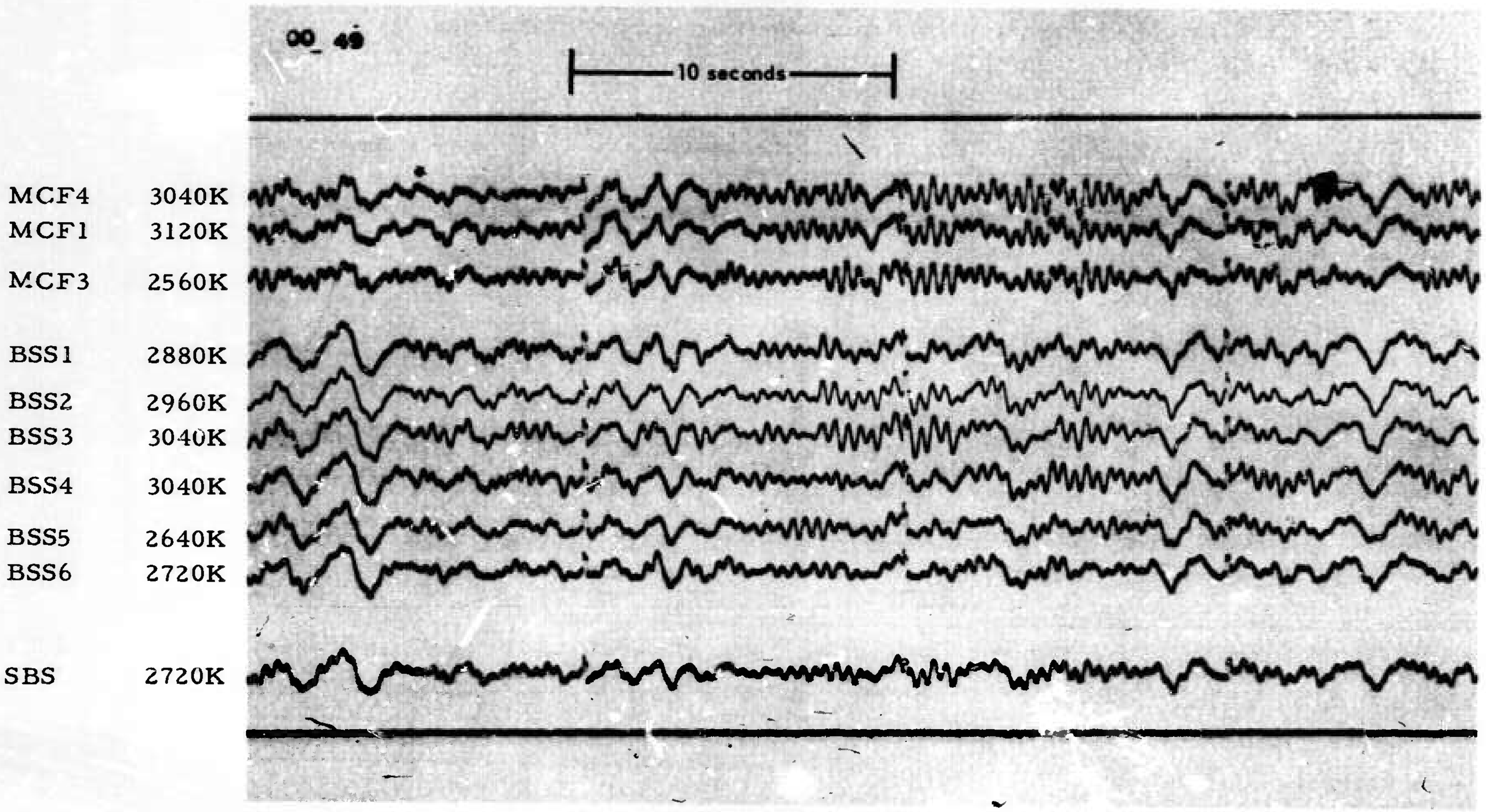


Figure 7. MAP I seismogram showing response of MAP I systems to high-frequency cultural noise from a north-northwesterly direction (X10 enlargement of 16-millimeter film)



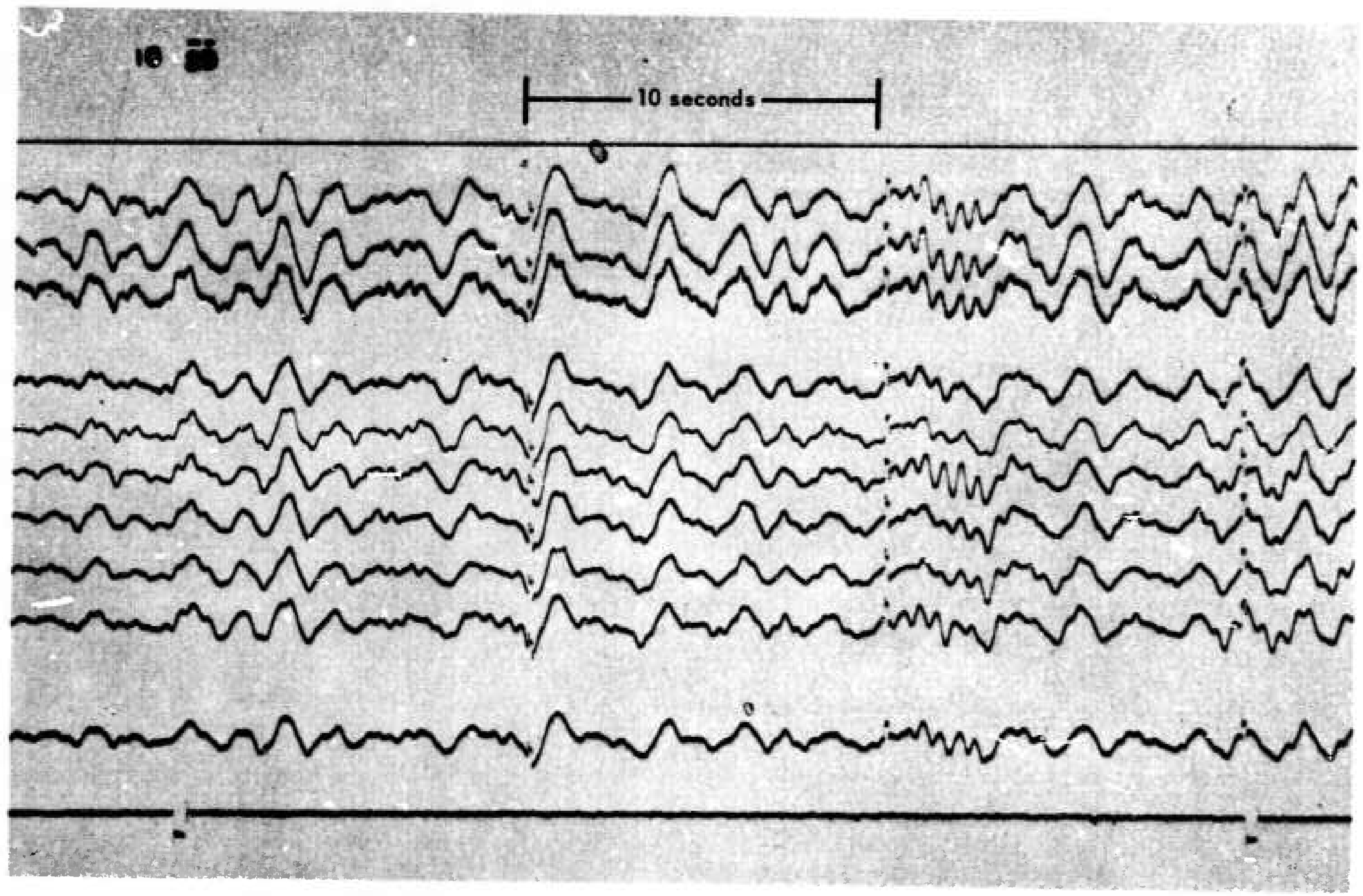
UBSO
13 Jan 67
RUN 013
DC 5070

Figure 8. MAP I seismogram showing response of MAP I systems to persistent high-frequency cultural noise from a north-northwesterly direction (X10 enlargement of 16-millimeter film)



UBSO
13 Jan 67
RUN 013
DG 5070

Figure 9. MAP I seismogram showing response of MAP I systems to high-frequency cultural noise arriving from an easterly direction (X10 enlargement of 16-millimeter film)



MCF4	2880K
MCF1	3200K
MCF3	2480K
BSS1	2720K
BSS2	2720K
BSS3	2720K
BSS4	2720K
BSS5	2720K
BSS6	2360K
SBS	2480K

UBSO
01 Jan 67
RUN 001
DG 5070

Figure 10. MAP I seismogram showing response of MAP I systems to high-frequency cultural noise arriving from a southeasterly direction (X10 enlargement of 16-millimeter film)

9.1.5 Change in Magnification of MAP II Channels

In order to make background noise levels more nearly equal on the various MAP outputs, the gains on MCF16 and MCF17 were increased by a factor of 2.0 and the gains on MCF14 and MCF15 and BSSV1 through BSSV6 were increased by a factor of 2.5 on 23 January.

9.2 ROUTINE NOISE MEASUREMENTS

Measurements of ambient noise in the 0.4 to 1.4 second period range are made daily at UBSO. Data are processed in Garland, and monthly cumulative probability curves of trace amplitudes and ground displacement are published. Noise data are reported from the Z10, SZ10, ΣT,ΣSΣT, ΣTF, and SΣTF seismograms. Noise curves for September through November 1966 were sent to the Project Officer during this reporting period.

10. PROVIDE OBSERVATORY FACILITIES AND ASSISTANCE TO OTHER ORGANIZATIONS

10.1 NASA SONIC BOOM STUDY

NASA has requested that UBSO provide time data for its use at Z1 during the UBSO part of the sonic boom study. To test the feasibility of sending time data from the central recording building to Z1 through a calibration line, UBSO personnel connected TCMDG data to the Z1 calibration line. The time code signal measured 1.0 volt peak-to-peak at Z1.

10.2 VISITORS

Sixteen cub scouts and the leaders of Pack 237 visited the observatory on 19 November.

Sandia Corporation representatives E. D. Zaffery and E. R. Stepka were at UBSO on 22 November working on the USO.

Mr. Robert L. Bucher, graduate student at the University of Utah, visited UBSO on 23 November. Mr. Bucher's PhD thesis will be a study of the crustal structure of Utah using long-period surface waves.

Messrs. Dennis R. Dalley and Ariel Michie, Utah State Health Department visited UBSO on 18 January to collect Develocorder water and slime samples for chemical analysis.

Mr. J. G. Swanson, Teledyne, was at UBSO from 23 January until 27 January to discuss plans for the MAP evaluation.

Mr. H. R. Henderson, NASA-LRC, was at UBSO on 25 and 26 January to discuss the sonic boom tests scheduled to be conducted at UBSO in February.

Mr. G. S. Gerlach, Teledyne, was at UBSO from 25 January until 27 January, discussing the UBSO part of the sonic boom study.

Mr. Harmen C. Senten, Benton Corporation, Salt Lake City, Utah, visited UBSO on 10 January to evaluate our air conditioning system preparatory to submitting a proposal and bid for modifying the system.

Messrs. E. D. Zaffery, D. F. Davis, and E. R. Stepka, Sandia Corporation, were at UBSO 31 January, working on the USO system.

1[illegible]. REPORTS

Technical Report No. 66-102, Operation of UBSO, Quarterly Report No. 2, Project VT/6705, was submitted for approval to the Project Officer on 8 November 1966 and was distributed 5 December 1966.

APPENDIX 1 to TECHNICAL REPORT No. 3

STATEMENT OF WORK

EXHIBIT "A"
STATEMENT OF WORK TO BE DONE
AFTAC Project Authorization No. VELA T/6705/S/ASD (32)

1. **Tasks:** 8 February 1966

a. **Operation:**

(1) Continue operation of the Uinta Basin Seismological Observatory (UBSO), normally recording data continuously.

(2) Evaluate the seismic data to determine optimum operational characteristics and make changes in the operating parameters as may be required to provide the most effective observatory possible. Addition and modification of instrumentation are within the scope of work. However, such instrument modifications and additions, data evaluation, and major parameter changes are subject to the prior approval of AFTAC.

(3) Conduct daily analysis of seismic data at the observatory and transmit daily seismic reports to the US Coast and Geodetic Survey, Wash DC 20230, using the established report format and detailed instructions.

(4) Record the results of daily analysis on magnetic tape in a format compatible with the automated bulletin program used by the Seismic Data Laboratory (SDL) in their preparation of the seismological bulletin of the VELA-UNIFORM seismological observatories. The format should be established by coordination with SDL through AFTAC. The schedule of routine shipments of these prepared magnetic tapes to SDL will be established by AFTAC.

(5) Establish quality control procedures and conduct quality control, as necessary, to assure the recording of high quality data on both magnetic tape and film. Past experience indicated that quality control review of one magnetic tape per magnetic tape recorder at the observatory each week is satisfactory unless quality control tolerances have been exceeded and the necessity of additional quality control arises. Quality control of magnetic tape should include, but need not necessarily be limited to, the following items:

(a) Completeness and accuracy of operation logs.

(b) Accuracy of observatory measurements of system noise and equivalent ground motion.

(c) Quality and completeness of voice comments.

(d) Examination of all calibrations to assure that clipping does not occur.

(e) Determination of relative phase shift on all array seismographs.

(f) Measurement of DC unbalance.

(g) Presence and accuracy of tape calibration and alignment.

(h) Check of uncompensated noise on each channel.

(i) Check of uncompensated signal-to-noise of channel 7.

(j) Check of general strength and quality of timing data derived from National Bureau of Standards Station WWV.

(k) Check of time pulse modulated 60 cps on channel 14 for adequate signal level and for presence of time pulses.

(l) Check of synchronization of digital time encoder with WWV.

(6) Provide observatory facilities, accompanying technical assistance by observatory personnel, and seismological data to requesting organizations and individuals after approval by AFTAC.

(7) Maintain, repair, protect, and preserve the facilities of the seismological observatory in good physical condition in accordance with sound industrial practice.

b. Instrument Evaluation: After approval by AFTAC, evaluate the performance characteristics of experimental or off-the-shelf equipment offering potential improvement in the performance of observatory seismograph systems. Operation and test of such instrumentation under field conditions should normally be preceded by laboratory test and evaluation.

c. Special Investigations: Conduct research investigations as approved or requested by AFTAC to obtain fundamental information which will lead to improvements in the detection capability of UBSO. These programs should take advantage of geological, meteorological, and seismological conditions at UBSO. The following special studies should be accomplished.

(1) Long term evaluation of the multiple array processor units.

(2) Installation and evaluation of a vertical array.

(3) Evaluation of the long-period vault.

(4) Provide technical assistance and monitor an unattended seismological observatory to be installed at UBSO in June 1967.

Research might pursue investigations in, but is not necessarily limited to, the following areas of interest: microseismic noise, signal characteristics, data presentation, detection threshold, and array design (surface and shallow borehole). Prior to commencing any research

EXHIBIT "A"

investigation, AFTAC approval of the proposed investigation and of a comprehensive program outline of the intended research must be obtained.

2. Approval by AFTAC will normally be provided through the project officer.

3. Reports: Provide reports in accordance with the Data requirements outlined in DD Form 1423 and attachment 1 thereto.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R&D

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10. AVAILABILITY/LIMITATION NOTICES

This document is subject to special export controls and each transmittal to foreign governments or foreign national may be made only with prior approval of the Chief of AFTAC.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Advanced Research Projects Agency Nuclear Test Detection Office Washington, D. C.

13. ABSTRACT

This report described the operation of the Uinta Basin Seismological Observatory from 1 November 1966 through 31 January 1967. Modifications and additions to the observatory instrumentation are described, and tests to improve the operation of the observatory are reported. Also discussed is the status of special investigations designed to evaluate and improve the detection capability of the observatory.

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Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Unattended Seismological Observatory						
Vertical Array						
Multichannel Array Processor						
Seismograph Operating Parameters						

INSTRUCTIONS

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